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C O N F I D E N T I A L

FINAL TERMINAL REPORT

FEBRUARY 1956

BUFFALO ARMS, INC.

BUFFALO 10, NEW YORK

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BUFFALO ARMS, INCORPORATED

SUBSIDIARY OF HOUDAILLE INDUSTRIES, INC.

BUFFALO 10, NEW YORK

FINAL TERMINAL REPORT

REPORT NUMBER SEVENTEEN

56-2-29-PR-17-BAI

FC

FEBRUARY 29, 1956

ROCHESTER ORDNANCE DISTRICT

ROCHESTER 4, NEW YORK

MAR 21 1956

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PAGE II

FOREWORD

This is a terminal report on Buffalo Arms, Inc., Research and Development Contract DA-30-115-ORD-577, originated August 1954, Amendment No. 2, dated 25 May 1955, and Amendment No. 3, dated 30 June 1955.

The following personnel were responsible for the administration, performance, testing and the preparation of monthly Progress Reports, submitted according to contract requirements.

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A B S T R A C T

The purpose of activities conducted under Contract DA-30-115-ORD-577 was for the improvement of the T-182 E2 - 30MM automatic revolver type weapon for increased endurance and functional reliability to meet U. S. Air Force requirements. Premature ending of the contract prevented completion of many notable projects which would enhance the endurance and functional reliability of the T-182 weapon.

Reliability of the T-182 - 30MM revolver type weapon, through design and development, was increased to 0.75 stoppage per 1,000 rounds in this program as evidenced by records of firing accomplished at this facility. However, with continued effort this stoppage rate could be decreased to a minimum of one stoppage per gun life.

It is recommended that continued attention be given the following components and/or areas of gun operation: drum support, recoil spring assembly, extraction system, the electrical system, actuator slide and rammer assembly, ammunition feed mechanism and barrel.

The program of weapon design simplification and weight reduction initiated at Buffalo Arms, Inc., should be continued to eliminate design complexities and gross weight.

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REPORT NUMBER SEVENTEEN

PAGE NUMBER ONE

TO: ROCHESTER ORDNANCE DISTRICT
ROCHESTER 4, NEW YORK

SUBJECT: 30MM AUTOMATIC WEAPON T-182
CONTRACT DA-30-115-ORD-577
FEBRUARY 29, 1956

INTRODUCTION:

This terminal report contains a summary of Research and Development activities performed at Buffalo Arms, Inc., authorized by Contract DA-30-115-ORD-577, conducted under the technical supervision of Springfield Armory Research and Development Branch.

The principle objectives of Buffalo Arms, Inc., Research and Development program were for development of the 30MM - T-182 weapon with increased endurance and functional reliability using high velocity T-239 ammunition.

The activities at Buffalo Arms, Inc. were conducted under a closely co-ordinated program involving two phases.

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PHASE I:

Within this phase of activity the weapon deficiencies and malfunctions encountered during acceptance and endurance firing were studied and analyzed. Results of these studies initiated design improvements in the T-182 gun for the elimination of malfunctions and enhancement of component endurance characteristics.

Limited quantities of experimental components were fabricated to the new designs and were evaluated by testing. All successfully tested components were duplicated in manufacture and samples distributed to Springfield Armory and all testing agencies for further evaluation before acceptance was made into standard weapon design.

PHASE II:

The initiation of the Phase II program was a result of extra scheduled study conducted by Buffalo Arms, Inc. for overall weapon design simplification, more economical production and increased functional reliability.

Overall weapon design studies propagated a revolutionary weapon design which would reduce practically all specially designed gun components by approximately 107, resulting in a T-182 - 30MM gun design capable of being fired from either right hand or left hand feed without additional components for conversion into opposite feed.

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Development activities to date resulted in submission of all but two areas of gun operation into actual testing. This is the dual purpose rammer and feed mechanism as outlined in report Number Sixteen. Continued effort in this field could produce functional rammers and feed mechanisms within a very short period of time.

TEST FIRING:**TESTING PROCEDURE**

Test firing schedules as directed by Springfield Armory were followed to evaluate endurance and functional reliability of the weapon.

The firing schedule in effect at the termination of this contract was as follows:

ONE COMPLIMENT:

1. 120 round burst
2. 3 minute cooling
3. 120 round burst
4. 3 minute cooling
5. 120 round burst
6. 15 minute cooling period before
starting next compliment

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TESTING CONDITIONS:

1. Horizontal mounted weapon
2. Rigid test stand - 1.090 deflection plate thickness
3. Flexible ammunition feed chute - manufactured by the Noble Engineering Company
4. Ammunition - T-239 Lot KOP 5-4
5. Links - T-64-E2
6. Barrel Orifice - .116 Diameter
7. Ammunition Box - Buffalo Arms, Inc. designed

SUMMARY OF TEST FIRING:

A total of 78,922 rounds of ammunition was fired within the testing phase under Contract DA-30-115-ORD-577. Fifteen test weapons were used in accumulation of the total amount of rounds. Two weapons received in January were not subjected to testing as a direct result of project termination.

GUN STOPPAGE RATE:

At the inception of the Product Improvement Program at Buffalo Arms, Inc. a stoppage rate of 16.9 stoppages/1000 rounds was experienced during the first month of testing. The unrelenting efforts during the entire program resulted in diminishing the overall stoppage rate to only 0.75 stoppages/1000 rounds, indicating a marked improvement of weapon effectiveness as a result of Buffalo Arms, Inc. contributory effort.

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Continuation of development effort would result in weapon effectiveness of fewer stoppages.

TABLE OF MONTHLY FIRING:

September 1954	1,117 rounds
October 1954	4,116 rounds
November 1954	3,447 rounds
December 1954	2,709 rounds
January 1955	5,660 rounds
February 1955	523 rounds
March 1955	926 rounds
April 1955	1,780 rounds
May 1955	1,995 rounds
June 1955	3,725 rounds
July 1955	1,968 rounds
August 1955	5,238 rounds
September 1955	10,753 rounds
October 1955	3,733 rounds
November 1955	14,072 rounds
December 1955	10,505 rounds
January 1956	6,655 rounds

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TEST WEAPONS:

Weapons allotted to Buffalo Arms, Inc., under Contract
DA-30-115-ORD-577:

<u>Item</u>	<u>Serial Number</u>	<u>Model</u>
1	10,012	T-182-E2 - Tool Room
2	10,014	T-182-E2 - Tool Room
3	10,016	T-182-E2 - Tool Room
4	10,031	T-182-E2 - Tool Room
5	10,046	T-182-E2 - Tool Room
6	10,067	T-182-E2 - Phase 1
7	10,089	T-182-E4 - 1A
8	10,092	T-182-E4 - 1A
9	10,093	T-182-E4 - 1A
10	10,161	T-182-E4 - 1B
11	10,181	T-182-E4 - 1C
12	10,183	T-182-E4 - 1C
13	10,184	T-182-E4 - 1C
14	10,187	T-182-E4 - 1C
15	10,202	T-182-E4 - 1H
16	10,222	T-182-E4 - 1C
17	10,231	T-182-E4 - 1C
18	1	T-182-E3 *

*Shipped to Buffalo Arms, Inc. for design study.

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ANVIL - SA-B-33522

INSULATION - SA-5006

PIN - SA-5008

INSULATION - SA-5006

INSULATION - SA-5006

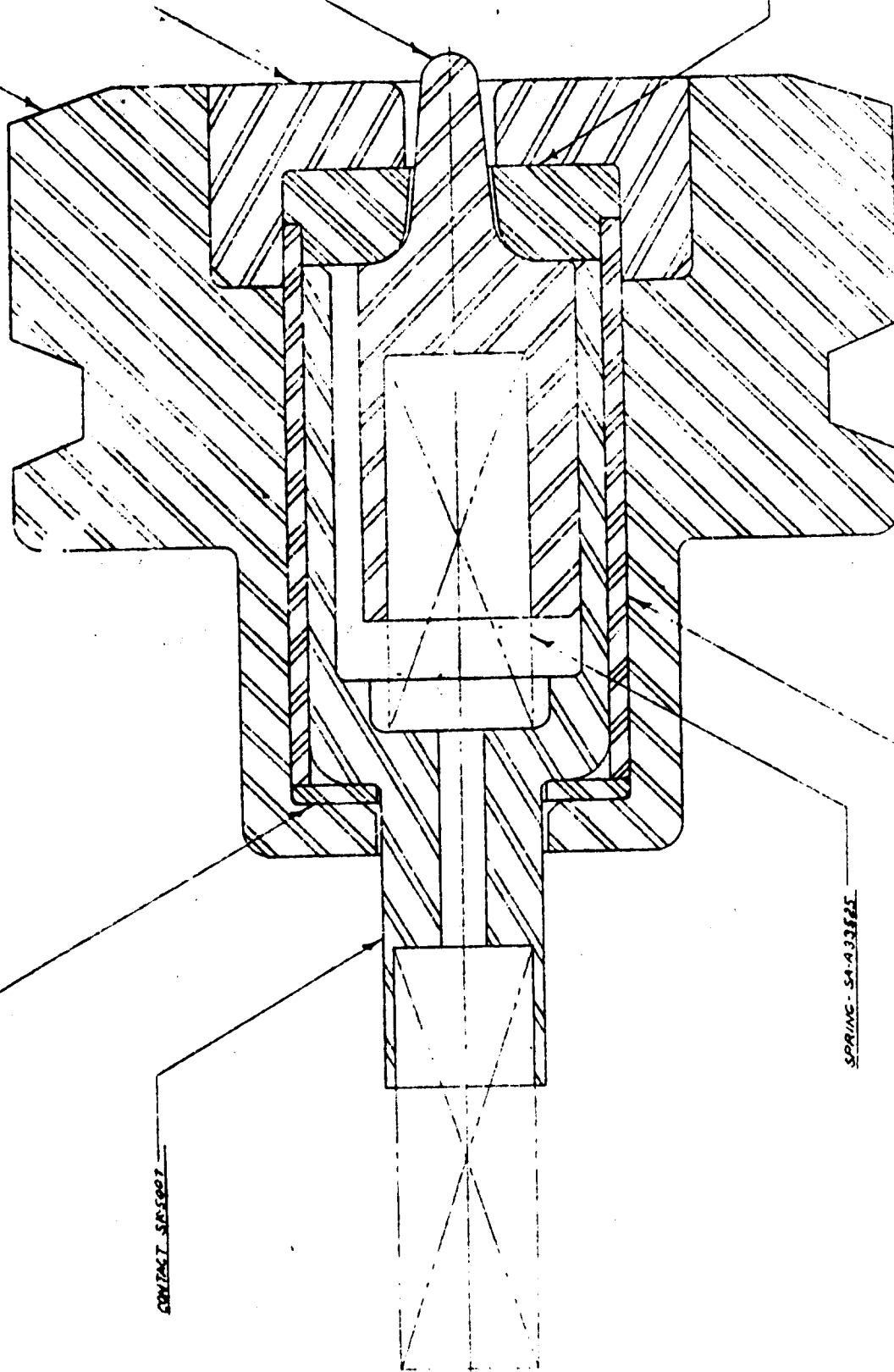
CONTACT - SA-5007

SPRING - SA-433521

INSULATION - SA-5005

BUFFALO ARMS FIRING PIN ASSEMBLY

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FIRING PIN ASSEMBLY:

The first design improvements of the firing pin assembly initiated in December 1954, resulted in a functional assembly with an endurance efficiency increase of 2000%.

Previously the firing pin assembly had an endurance life of only 500 rounds. Testing results at this facility with the Buffalo Arms, Inc. designed firing pin indicated a service life well over 10,000 rounds. To discount the possibility of having optimum conditions for subjecting this design in test, additional assemblies were manufactured and distributed to other testing agencies for evaluation of this design.

Favorable results were obtained at other testing agencies which reported endurance life in excess of 15,000 rounds per assembly. (See Exhibit "A" 2-55) This firing pin design was used exclusively during 70,242 rounds of firing in the development program at this range with excellent performance.

All testing facilities during 1955 reported equally satisfactory performance.

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CONTACT PLUNGER - #7266903:

The excellent performance of the Buffalo Arms, Inc. re-designed contact plunger completely eliminated the various difficulties experienced with the electrical system in that area of operation. This design, outlined in Report Number Four, was immediately adopted as standard to weapon design. Its performance has continued unfailingly under all conditions presented.

Additional features were incorporated within the design to greatly simplify the tedious assembly of the electrical harness.

BARREL:

Extensive effort was expended in the development of a reliable gun barrel and drum seals which originally displayed practically no serviceable life at the onset with T-239 high pressure - high velocity ammunition.

The initiation of T-239 ammunition into the testing program virtually stopped the testing program because of the many weapon weaknesses revealed by this ammunition.

All efforts were concentrated on the areas of weakness to increase the endurance of gun barrels, drums, drum seals, extractor pawls, extractor shafts, switch cams, receiver assembly, drive spring guides and slide actuator and rammer assemblies.

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Studies of manufacturing techniques and processes were made with an outlined course of action to be taken to increase component endurance characteristics. Results were immediately apparent with increases of endurance in the gun barrel from 65 rounds to 385 rounds. Continued experimentation with induction hardening of the breech end has resulted in component life of approximately 1,200 rounds, outlined in Report Number Five and subsequent reports.

Refinements of all designs tested resulted in a barrel as outlined in Report Number Twelve. Ten experimental barrels and mating components are 95% complete at this time.

CAPPED BARREL:

In order to provide a gun barrel with sufficient physical properties to withstand the extremely high firing temperatures at the breech end of the barrel, Buffalo Arms, Inc. developed the capped barrel. This barrel consists of a standard barrel remachined with the addition of a heat resisting cap made of Carpenter #883 steel. The assembly of the barrel was accomplished by shrinking the cap to the breech end of the barrel.

Excellent results were obtained from these experimental barrels each of which displayed minimum endurance of 1,700 rounds. Testing conditions for these capped barrels were far from ideal because the drum seals used at the time imparted extremely high firing loads.

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Further testing of the capped barrel with the recently designed fluted chambered drum, was discontinued by the termination of the development contract. However, limited results were most favorable. It is urged that the employment of the Buffalo Arms, Inc. capped barrel with the recently designed fluted chambered drum, should be further investigated to determine its potential possibilities.

SELECTOR VALVE ASSEMBLY:

To eliminate the many difficulties experienced with the selector valve system at the onset of the program, Buffalo Arms, Inc. designed two selector valve assemblies outlined in Report Number Three and subsequent reports.

Favorable progress with these assemblies was made resulting in functional components.

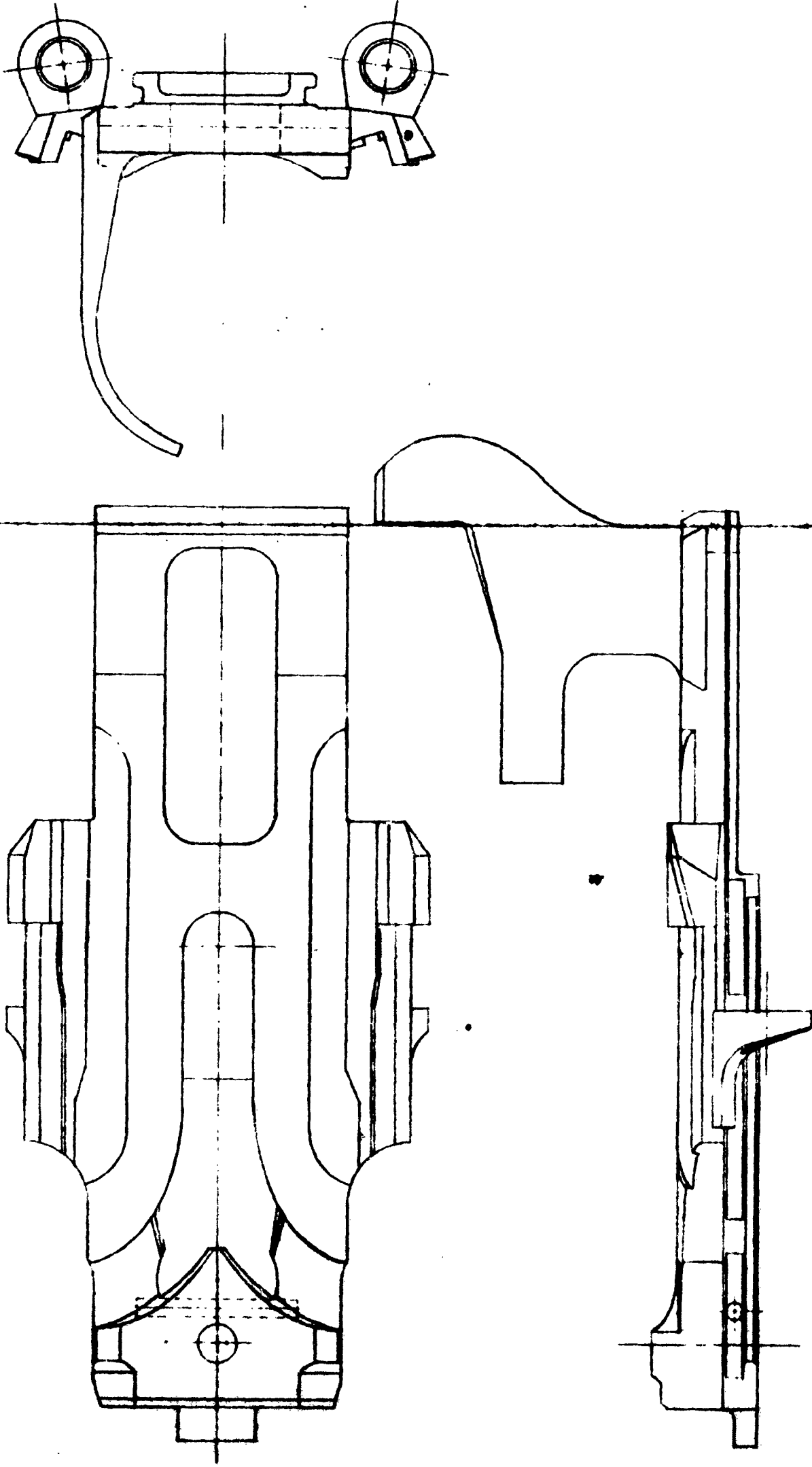
Efforts were discontinued at Buffalo Arms, Inc. when other agencies reported more favorable progress with similiarly designed assemblies.

SLIDE ACTUATOR:

Component improvements for the elimination of frequent malfunctions and increased functional reliability resulted in an original slide actuator design capable of being assembled into a standard weapon without special provision. Based on studies completed early in the program during the investigation

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BUFFALO ARMS, INC. ONE PIECE SLIDE

FRONT LOADING

EXHIBIT "B" 2-56

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of possibilities of eliminating useless gun components, Buffalo Arms, Inc. initiated design activities for a slide actuator, rammer combination. The resultant design eliminated the eight components which invariably caused malfunctions and weapon stoppages. (See Exhibit "B" 2-56)

Comparative tests were recently conducted using Model T-182 E4 1G guns with slide actuators of Buffalo Arms, Inc. design and other development agencies. As reported during February 3, 1956, Research and Development Technical Meeting at Springfield Armory, Buffalo Arms, Inc. designed slide actuator assembly successfully met minimum gun endurance requirements of 5,000 rounds.

Tests were discontinued at Springfield and Eglin Air Force Base on other development agencies' design due to broken components.

A second version of the combination slide actuator design was being closely phased to include provisions for the improved Buffalo Arms, Inc. wiring harness, dual purpose extractor shaft and the dual purpose rammer. Fabrication of this design was temporarily held up in December pending test results of prototype slides.

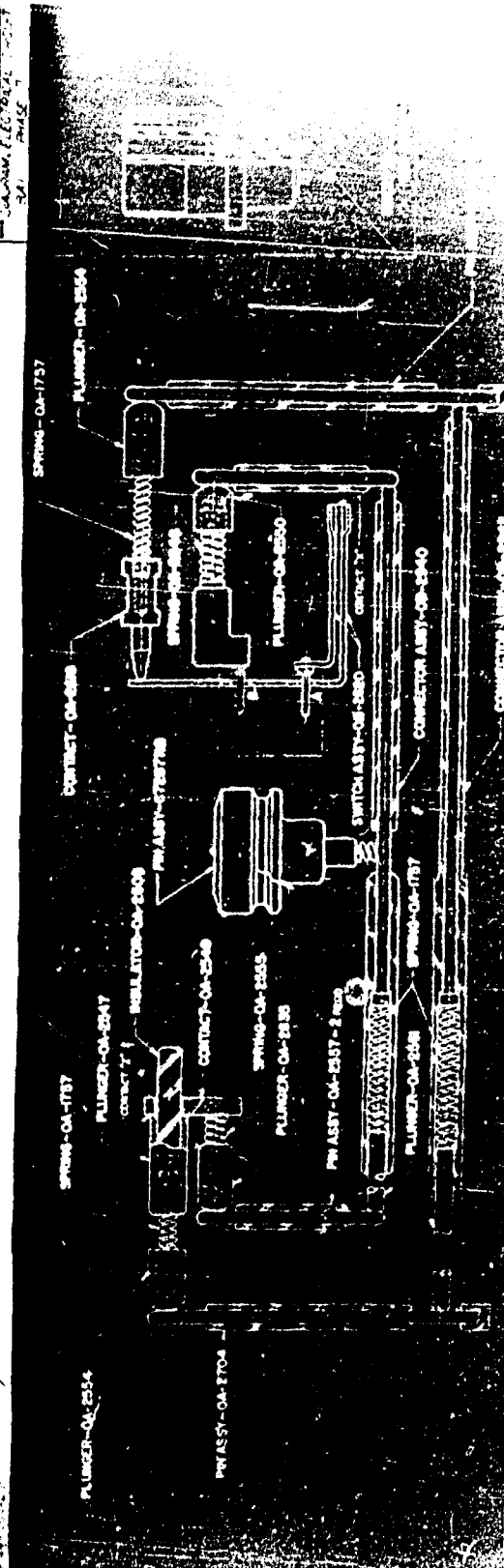
Improvement effort along these lines should be continued for advancement of the T-182 weapon.

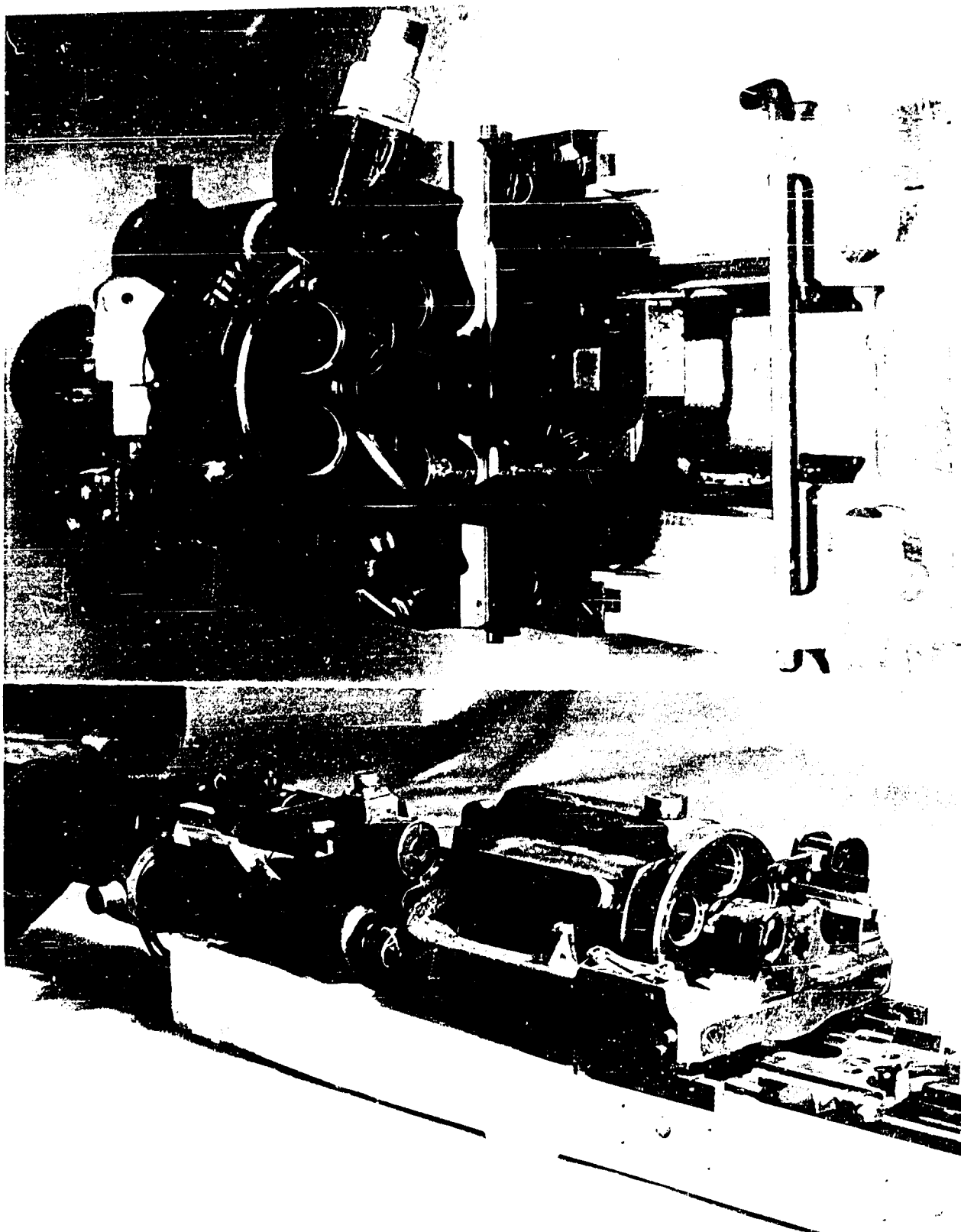
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Buffalo Arms, Inc.

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WIRING HARNESS (Simplified):

Report Number Twelve and subsequent reports outlined in detail the Buffalo Arms, Inc., improved electrical wiring harness for the T-182 weapon. This simplified design is a combination of only twenty-eight components, as compared to the troublesome standard wiring harness which consists of forty-six components. (See Exhibit "C" 2-56) Electrically, the improved design functions identically to the standard harness due to functional necessity. The complete elimination of the troublesome molded switch assembly and power lead in assembly was accomplished by providing a housing and power lead in connector into the already proven prototype anti double feed switch system which was successfully tested for over 60,000 rounds.

A fabrication program was immediately instituted for a limited quantity of units to be assembled into special drum supports for test. The simplicity of this harness requires less machining of the drum support body. Therefore, a limited number of drum supports were started in manufacture to meet the harness design. Exhibit "D" 2-56 is a photograph of the test gun used in preliminary test of the wiring harness. Note the simplicity of gun profile without the aluminum contact housing and power lead in assembly which was located on the left hand side of the gun.

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Insufficient funds did not permit extensive testing of the prototype wiring harness which exhibited satisfactory performance in tests during January.

DRIVE SPRING GUIDE ASSEMBLY:

The marginal success of the standard drive spring guide assemblies prompted design studies and immediate action for elimination of poor functional quality the standard design embodied.

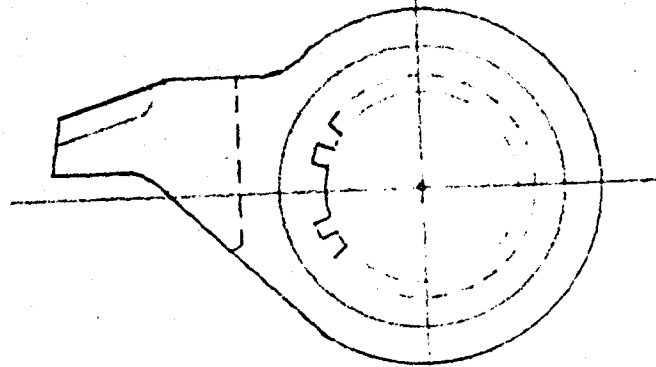
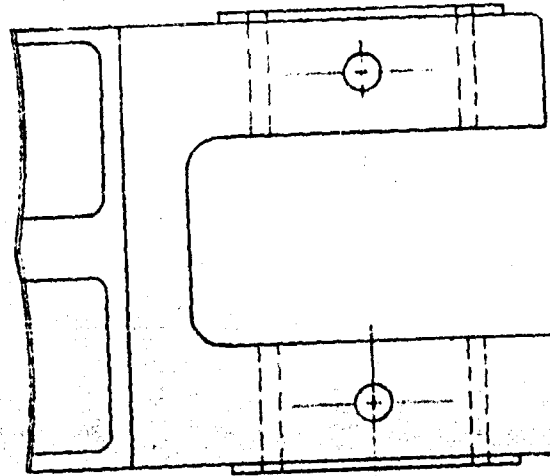
The very successful designs, as outlined in Buffalo Arms, Inc., Reports Number Nine, Ten and subsequent reports, were tested well over 20,000 rounds without failure or malfunction. This design overcomes the battering and mutilation of the soft receiver body caused by the surging action of the drive springs.

Design refinements included a locking arrangement as outlined in Report Number Twelve. Performance of the rear lock drive spring guides completely met all expectations in testing. Receiver body battering and mutilation was completely eliminated. Consequently, removal of drive springs is easily accomplished, since no upsetting of receiver material occurs. This design and principle should be adopted into the standard T-182 weapon design.

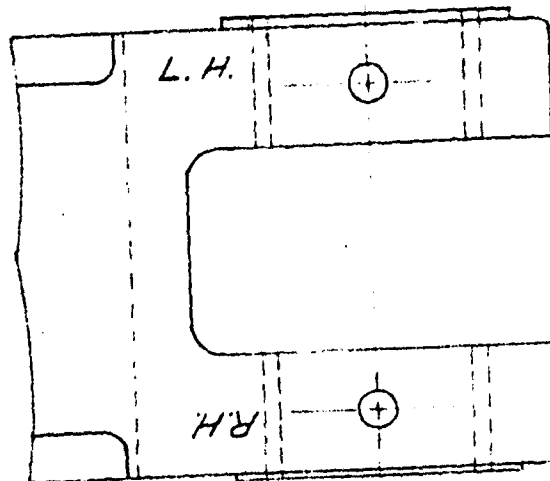
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EXHIBIT 'E' 2-56



NON HANDED EXTRACTOR PAWL



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EXTRACTOR PAWL:

Following Springfield Armory directive, dated 23 November 1954 to improve the extraction system, Buffalo Arms, Inc. investigations and studies resulted in a dual purpose extractor pawl design, outlined in Report Number Six. (See Exhibit "E" 2-56). The extractor pawl was function fired for more than 60,000 rounds during the development program which indicates a substantially improved design possessing the required endurance characteristics to sustain the rigorous service of gun operation.

This design eliminated the need for making individual left hand and individual right hand components by incorporating the dual purpose feature. Operating in opposite feed position is equally satisfactory and accomplished by proper assembly to the extractor shaft.

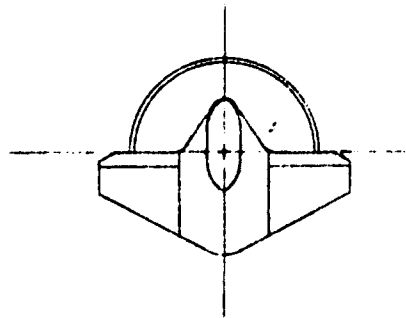
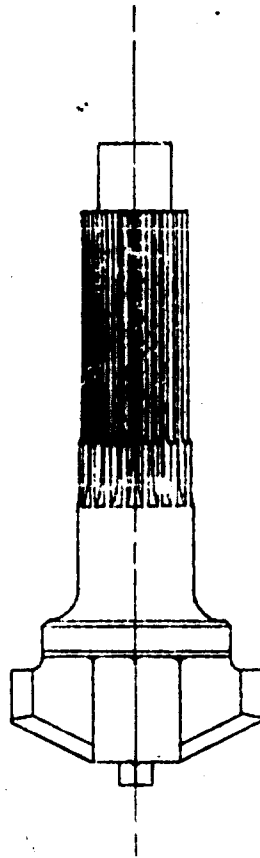
EXTRACTOR SHAFT:

Design effort in this area for component improvement produced another dual purpose component. The standard weapons use individually designed components for right hand guns and left hand guns. The Buffalo Arms, Inc. design dual purpose extractor shaft (See Report Number Sixteen) was committed to test in January just prior to the termination of the development contract. The limited amount of testing proved satisfactory. However, extensive testing would determine whether any difficulties still existed within this design.

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EXHIBIT "F" 2-56

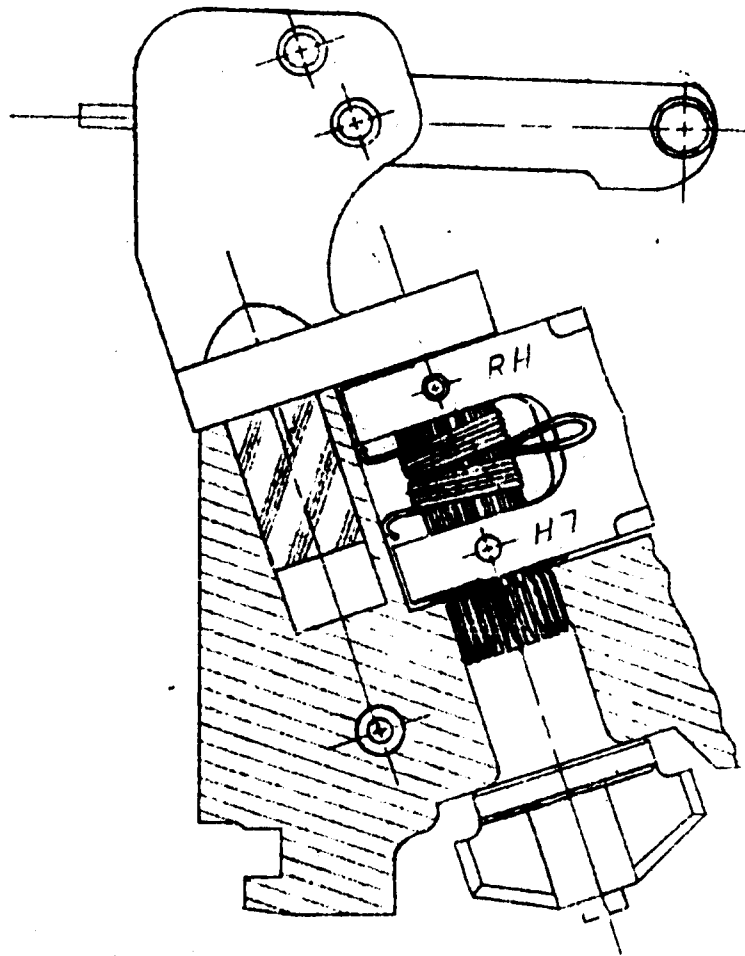


EXTRACTOR SHAFT - DUAL PURPOSE

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PHASE II - ANTI DOUBLE FEED SWITCH
ASSEMBLY ; EXTRACTOR PAWL &
EXTRACTOR SHAFT

EXHIBIT "G." 50

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A symmetrical arrangement for the assembly of the pawl on the extractor shaft was necessary in order to utilize the dual purpose feature of the two components. A hexagon shaft cross section was originally used which proved inadequate to meet the requirement. A fix was made on an even number of splines with equal guide keys located 180° apart. This arrangement proved more that adequate for the requirement and function was equally satisfactory.

To utilize the dual purpose extractor shaft, the standard return cam was substituted by a return cam machined below the operating area on slide actuator. A detailed outline was made in Report Number Ten. Consistent progress was made in this area of operation to provide a positive return cam path. A small amount of additional effort that the contract allowed for, could have resulted in a 100% functional arrangement and added to improvement of the overall weapon design simplification.

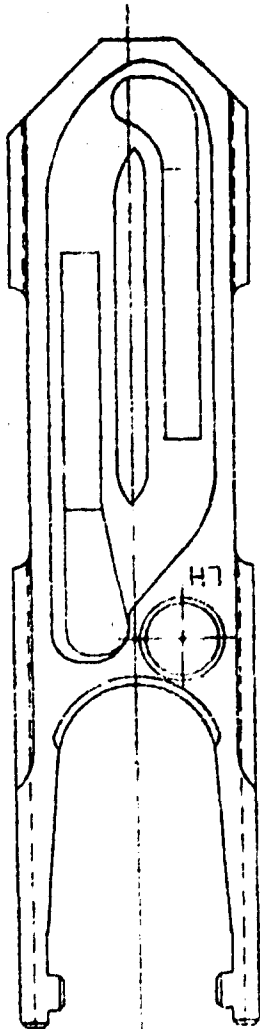
ANTI DOUBLE FEED SWITCH SYSTEM:

Buffalo Arms, Inc. weapon improvement program initiated the design of the anti double feed switch system which diminished the anti double feed design from twenty to only seven components. The simplified design also possesses the dual purpose feature. Basically, the 30MM T-182 weapon is an electrically operated weapon, therefore, it is of the utmost importance to be able to remove the firing voltage from the weapon in the event of poor extraction. The Buffalo Arms, Inc. design

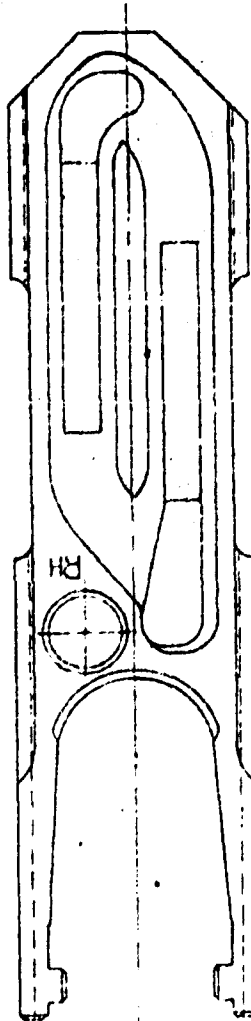
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EXHIBIT "I" 2-56



LEFT HAND CAM SWITCH



RIGHT HAND CAM SWITCH

BUFFALO ARMS PHASE II CAM SWITCH - DUAL PURPOSE

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provides accurate and positive control of the firing voltage at all times and definite functional reliability as indicated by over 65,000 rounds of firing at this test range only. Reports from other testing agencies confirm the excellent performance experienced.

SWITCH CAM:

The improvement and weapon simplification program which Buffalo Arms, Inc. initiated during the development of a 30MM weapon, to eliminate all single purpose components as outlined under heading of Phase II program, Buffalo Arms, Inc. designed and fabricated the dual purpose switch cam. (See Exhibit "I" 2-56). Constant improvement was made on this design until the endurance and functional reliability exceeded gun requirements as indicated by 33,785 rounds of successful testing. Design refinements on the switch cam and mating components were accomplished without additional weight to the gun.

Component designs were made with emphasis on function and reliability without overlooking the all important ease of production manufacturing. From the manufacturing standpoint, special components involve considerable time, tooling and money which invariably keeps the unit cost of the product on a unnecessarily high level.

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The design simplification program at Buffalo Arms, Inc. at all times stressed the desire to eliminate special left hand and right hand tooling required in the production of the T-182 weapon. The reduction of special gun components, as outlined in previous pages, would result in diminishing unit cost, advancement toward standardization, simplify manufacture, reduce weapon maintenance difficulties and simplify warehousing of Ordnance material.

RAMMER AND AMMUNITION FEED MECHANISM:

As indicated in previous Buffalo Arms, Inc. reports, dual purpose rammer and ammunition feed mechanisms could be successfully developed. Studies completed (Reported in detail in Report Number Sixteen) prior to the termination of the development contract indicated the benefits to be gained in the use of a dual purpose feed mechanism.

The sheet metal feeder at present possesses marginal endurance characteristics and dimensional stability. Control of cartridges is poor during de-linking and ramming. This is evidenced by the mutilation of the projectile as a result of ramming. This condition would be extremely unfavorable with "H E1" ammunition. Poor cartridge control causes an excessive amount of chips which eventually can short the electrical system.

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The dual purpose feed mechanism of Buffalo Arms, Inc. design would provide for better cartridge control by eliminating the projectile mutilation and chip evolution. As indicated previously, the dual purpose feeder would contain approximately sixty-five components. The present design now requires one hundred and fifty components for left hand and right hand operation.

PIN PLATE, TONGUE PIVOT:

In order to eliminate the many gun stoppages caused directly by the failure of the tongue pivot pin, Buffalo Arms, Inc. designed and began fabrication of the tongue pivot pin. Premature termination of the development contract did not permit the evaluation by testing of this design. From the design standpoint, this component possesses all the desirable features for unfailing operation. A detailed outline of the pin plate was made in Report Number Sixteen.

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RECOMMENDATIONS:

It is recommended that:

1. New design approach to the ammunition feed system be undertaken to eliminate marginal performance of the welded sheet metal feeder.
2. Pursuit of weapon design to eliminate the vast amount of specially designed single purpose components.
3. Continue design efforts initiated at Buffalo Arms, Inc. to produce a basic weapon which can be fired from either hand feed without additional components, outlined under Buffalo Arms, Inc., Phase II program.
4. Realistic approach to component design relative to production manufacturing techniques and capabilities available in industry for overall unit cost reduction.

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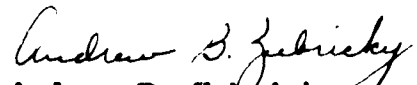
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CONCLUSION:

Design and development efforts at Buffalo Arms, Inc. greatly contributed to the overall T-182 weapon development. As indicated in previous pages and reports, the effectiveness of the T-182 weapon was increased from 16.9 stoppages per 1,000 rounds to 0.75 stoppages per 1,000 rounds. This effectiveness, although greatly improved, could, with continued effort, be further advanced.

Respectfully submitted,

Andrew B. Zubricky,
Buffalo Arms, Incorporated**CONFIDENTIAL**

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